Utilization Of Geo-Grid For Improving The Strength Of Subgrade Layer With Fly-Ash

Basudeb Paul[1] and Sanjay Paul[2]

[1] Department of Civil Engineering, National Institute of Technology Agartala, PIN – 799046, India
jonty28april@gmail.com
[2] Department of Civil Engineering, National Institute of Technology Agartala, PIN – 799046, India
sanjaypaul76@gmail.com

Abstract. The present study aims at exploring the possibilities of utilization of fly ash and geo-grid for rural road. The performance of fly ash and geo-grid reinforced with soil is studied by conducting California Bearing Ratio (CBR) test. Studies have been carried out by considering different percentages of fly ash by placing the geo-grid sheets within the different depth positions. The motivation of the present work is to reach the soaked CBR value of a subgrade layer which is above 10%, as per I.R.C.: S.P.-72-2007. Under the soaked condition the geo-grid shows the maximum penetration resistance and give greater CBR values. The soaked CBR values of soil-fly ash mixed with geo-grid at different depths of single layer show that, the CBR values decrease continuously with the increase in the depth of geo-grid. Also the optimum position of geo-grid to get higher value of CBR is 0.2*H* from the top of the specimen, where *H* is the total height of the soil specimen in CBR mould.

Keywords: Soil, Fly-ash, Geo-grid, CBR, Subgrade.

1 Introduction

The performance of a pavement is very responsive to the characteristics of the soil subgrade, which provides base for the whole pavement structure. The present study aims at exploring the possibilities of utilization of fly ash and geo-grid for the improvement of rural road. Number of research works have been carried out to improve the performance of subgrade soil by mixing it with fly ash and geo-grid according to [3], [6] and [7]. The performance of fly ash and geo-grid reinforced with soil have been studied by conducting California Bearing Ratio (CBR) test. In the present case, the studies have been carried out by adding soil with different percentages of fly ash and combining them with the geo-grids along the different depth positions.

2 Motivation and Objective

In this study fly ash and geo-grids have been used as stabilizing materials. According to [4], the soaked CBR value of a subgrade layer is above 10%. The motivation in this paper is to achieve this CBR value by using different percentages of fly ash mixed with the soils layered with geo-grid at different single layered depths.

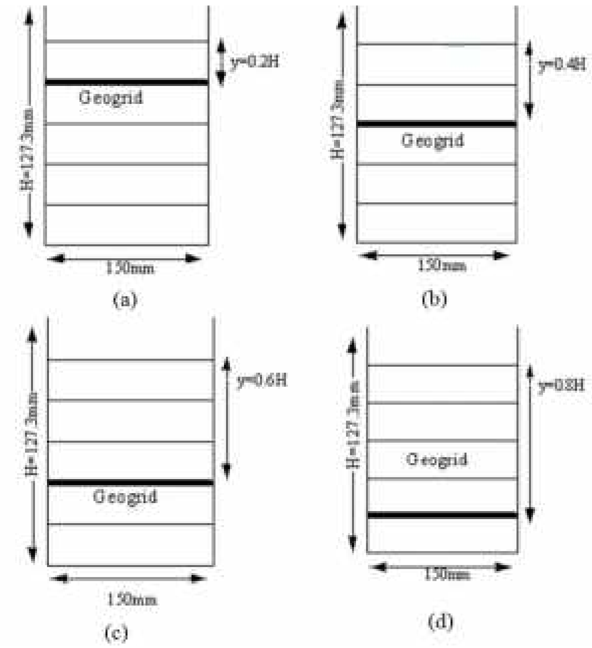

Fig. 1. Placement of geo-grid against the different depths CBR mould.

3 Methodology

Different laboratory experiments have been performed to find out the physical and engineering properties of the soils collected from N.I.T. Agartala campus, Tripura, India (Table 1). The fly ash sample was collected from Kolaghat Thermal Power Plant, West Bengal, India having specific gravity 1.98.

The dry soil sample has been mixed with different percentages of fly ash (10%, 20%, 30% and 40%) and also reinforced with geo-grid at different placement depth as shown in figure 1. The heavy compaction tests have been performed to find the maximum dry density (M.D.D.) and optimum moisture content (O.M.C.) of the soil. Also the California bearing ratio (CBR) values of the soil mixed with fly ash and reinforced with geo-grid in different depths (0.1H, 0.2*H*, 0.3H, 0.4*H*, 0.6*H*, 0.8*H*, where *H* is the thickness of the soil layer) are performed according to [5].

Properties of Geo-grids

Biaxial Geogrids are collected from the Kolkata new market (makers TENSAR). Thickness of this geo grid is 1.50mm and grid size is 10 mm × 10 mm.

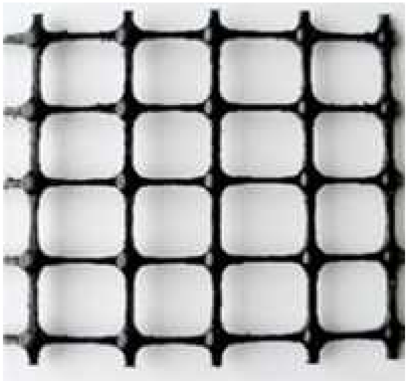

Fig. 2. Photo of geo-grid.

Table 1. Physical and Engineering properties soil sample.

Physical Properties	Experimental data
Specific Gravity (G)	2.60
Sand particles (0.075mm-4.75mm, %)	53.28
Silt particles (0.002 mm-0.075 mm, %)	35.32
Clay particles (<0.002 mm, %)	11.40
Name of the group & symbol	Silty – Sand (SW-SM)
M.D.D. (gm/cc) [Heavy compaction]	2.00
O.M.C. (%) [Heavy compaction]	11.80

4 Results and Discussions

The CBR values of soil and fly ash mixtures have been obtained under soaked conditions. Also the soaked CBR values have been obtained by combining soil, fly ash and geo-grid together.

4.1 CBR values of soil and soil – fly ash combinations

The soaked CBR tests have been performed for the soil and the soil mixed with fly ash at different percentage which are presented in table 2. It is observed that, the maximum value of the CBR is attained after adding an optimum percentage of fly ash, beyond that the CBR value reduces.

The gain of strength of fly ash stabilized soil is primarily a result of pozzolanic reactions between silica and alumina from the soil and fly ash to from various type of cementing agent in presence of water. Similar trends have been obtained according to [1] and [8].

Table 2. Variation of CBR with soil and soil – fly ash combinations under soaked conditions.

Sl No.	Combinations of soil and fly ash		CBR Value (%)	Relative increase in CBR value (%)	Percentage increase in CBR value
	Percentage of soil	Percentage of fly ash			
1	100	0	4.65	-----	-----
2	90	10	5.43	0.78	16.77
3	80	20	6.7	2.05	44.08
4	70	30	7.58	2.93	63.01
5	60	40	7.09	2.44	52.47

4.2 CBR values of soil, fly ash and geo-grid combinations

The soaked CBR tests have been performed for the soil and the soil mixed with fly ash at different percentage combinations against the different depth of placement of geo-grid under soaked conditions according to figure 1.

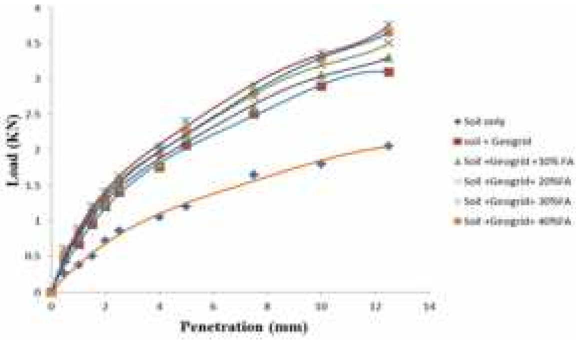

Fig. 3. Soaked CBR test result considering Geogrid at 0.1H depth.

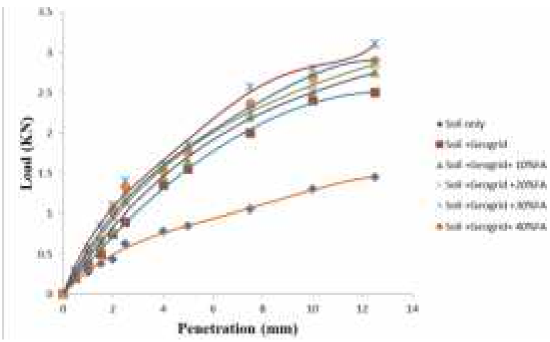

Fig. 4. Soaked CBR test result considering Geogrid at 0.2H depth.

Figures 3 and 4 show typical CBR test results under soaked conditions considering the Geogrid at 0.1H and 0.2H depth respectively. The CBR test results are also presented in table 3. The geo-grids have been placed at 0.1H, 0.2H, 0.3H, 0.4H, 0.6H, and 0.8H depth from the upper portion of CBR mould.

Table 3. Variation of CBR with soil and soil – fly ash (FA) combinations against the different depth of placement of geo-grid under soaked conditions.

Sl No.	Depth of placement of geo- grid	Percentage of fly ash	CBR Value (%)	Relative increase in CBR value (%)	Percentage increase in CBR value
1	-----	-----	4.65	----	----
2	0.1*H*	0	5.07	0.42	9.03
3	0.1*H*	10	5.23	0.58	12.47
4	0.1*H*	20	5.36	0.71	15.26
5	0.1*H*	30	5.61	0.96	20.64
6	0.1*H*	40	5.58	0.93	20.00
7	0.2*H*	0	7.30	2.65	56.90
8	0.2*H*	10	8.40	3.75	80.60
9	0.2*H*	20	9.20	3.95	97.80
10	0.2*H*	30	10.2	5.55	119.3
11	0.2*H*	40	9.65	4.05	107.5
12	0.3*H*	0	6.13	1.48	31.83
13	0.3*H*	10	6.27	1.62	34.84
14	0.3*H*	20	6.41	1.76	37.85
15	0.3*H*	30	6.92	2.27	48.82
16	0.3*H*	40	6.87	2.22	47.74
17	0.4*H*	0	6.80	2.15	46.23
18	0.4*H*	10	7.30	2.65	56.98
19	0.4*H*	20	7.80	3.15	67.75
20	0.4*H*	30	8.50	3.85	82.8
21	0.4*H*	40	7.95	3.3	70.97
22	0.6*H*	0	6.60	1.95	41.94
23	0.6*H*	10	7.10	2.45	52.70
24	0.6*H*	20	7.60	2.95	63.40
25	0.6*H*	30	8.02	3.37	72.47
26	0.6*H*	40	7.81	3.16	67.95
27	0.8*H*	0	6.46	1.91	41.07
28	0.8*H*	10	6.93	2.28	49.03
29	0.8*H*	20	7.30	2.65	56.98
30	0.8*H*	30	7.73	3.08	66.25
31	0.8*H*	40	7.44	2.79	60.00

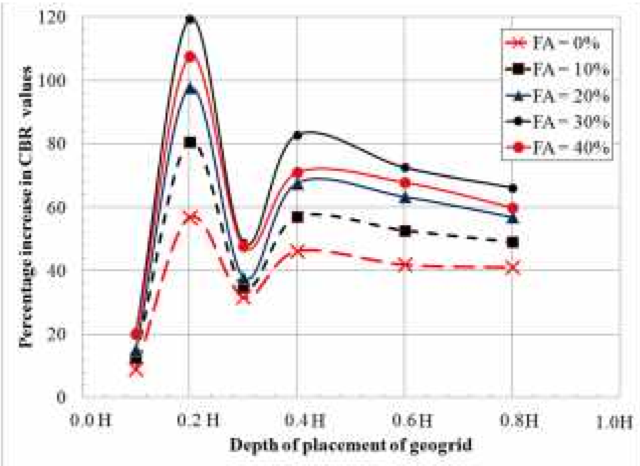

Fig. 5. Variation of percentage increase in CBR values against the depth of placement of geogrid for different flyash percentages (FA), where H is the thickness of the soil layer.

Figure 5 shows the variation of percentage increase in CBR values against the depth of placement of geogrid for different flyash percentages. It has been observed that use of geo-grid with different percentage of fly ash plays an important role in the performance of CBR values. Under the soaked condition the geo-grid shows the maximum penetration resistance and give greater CBR values. This is because it has a very good interlocking and frictional capability and therefore provides the high tensile resistance any lateral movement of soil and therefore improves the strength of soil. For all placement depth this behavior is similar.

It can be observed that the CBR values decrease continuously with the increase in the depth of geo-grid. Thus it is concluded that lowering the position of geo-grid actually reduces the percentage increase in CBR values of soil.

The stress applied by the CBR plunger is distributed according to boussinesq equation of stress distribution [2]. Applying [2], stress developed at the level of different position of geo-grid in summarized in table 4. Introduction of geo-grid at a depth of 0.2*H* where 63.70% of stress is coming will show lower strain as the grid has got higher modulus of elasticity than soil. This justifies getting higher CBR value at this position.

The results obtained from the present study may be comparable with the finding by the previous researchers [9].

Table 4. Stress developed at different position of geo-grid in CBR mould.

Depth of reinforcing layer from the top	% stress
0.1H	7.68
0.2*H*	63.70
0.3H	41.03
0.4*H*	27.70
0.6*H*	14.20
0.8*H*	8.40

5 Conclusions

Based on the above results and details discussions following conclusions may be made:

* The maximum value of the CBR is attained after adding an optimum percentage of fly ash, beyond that the CBR value reduces.

* Under the soaked condition the geo-grid shows the maximum penetration resistance and give greater CBR values.

* The CBR values decrease continuously with the increase in the depth of geo-grid, thus lowering the position of geo-grid actually reduces the percentage increase in CBR values of soil.

* Using geo-grid at a depth of 0.2H (H is soil specimen height in CBR mould) shows higher percentage of stress (63.70%), which will show lower strain as the grid has got higher modulus of elasticity than soil. This justifies getting higher CBR value at this position.

References

1. Anupam, A.K, Kumar, P, Ransinchung, G.D.: , Use of Various Agricultural and Industrial Waste Materials in Road Construction, Social and Behavioral Sciences, 104,264-273 (2013).
2. Boussinesq , J.V.: Application of potentials to the study of the equilibrium and the movement of elastic solids, Gauthier-Villars (1885).
3. Gajendra, V. and Kumar, N.D.: Comparative Study on Soft Soil Stabilisation of Pavement Subgrade by using Flyash, Lime and Geogrid, IOSR Journal of Mechanical and Civil Engineering, pp. 70 – 78 (2008).

4. IRC-SP-72: Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads (2007).
5. IS 2720-16: Methods of test for soils, Part 16: Laboratory determination of CBR (1981).
6. Kumar, S. and Mahla, R.P.: CBR Improvement of Soil by Adding Lime and Fly Ash, International Journal for Research in Applied Science & Engineering Technology, Volume 3 Issue VI (2015).
7. Kumar, S., Chouksey, A. and Priyanka: Stabilization of sub-grade using fly ash and geosynthetic material, International Journal of Advanced Technology in Engineering and Science, Vol. No.5, Issue No. 06, (2017).
8. Ramesh, A. and Kumar, M.: An Experimental Investigation on coir fiber and fly ash in stabilized mechanistic pavement, Indian Geotechnical Society, Guntur, India (2009).
9. Singh, P. and Gill, K.S.: CBR Improvement of clayey soil with Geo-grid Reinforcement, IJETAE, vol. 2, pp. 315-318, 2012.